III. RAILYARD OPTIONS

This chapter provides evaluations of potential options to enhance and accelerate non-locomotive emission reductions within railyards. These options would primarily apply to intermodal railyards where operations include the use of non-locomotive sources such as: cargo handling equipment (CHE), heavy-duty (HD) diesel trucks, transport refrigeration units (TRUs), off-road equipment, and stationary sources. The evaluations are based on the following criteria: technical feasibility, potential emission reductions, costs, and cost-effectiveness.

A. Cargo Handling Equipment

1. Background

Cargo Handling Equipment is used to stack and move cargo containers, the most common type of cargo at intermodal railyards. This equipment includes: yard trucks, rubber-tired gantry cranes, top picks, side picks, forklifts, and straddle carriers. Cargo handling equipment is typically powered by off-road compression-ignition diesel engines, however, there is some equipment powered by on-road compression-ignition diesel engines. In 2004, the U.S. E.P.A promulgated new emission standards for off-road and on-road engines. Table III-1 lists these standards.

Table III-1: Cargo Handling Equipment
U.S. EPA On-Road and Off-Road Emissions Standards

Class	NOx (g/bhp-hr)	PM (g/bhp-hr)
On-Road		
2004 -2006	2.0	0.10
2007+	0.2	0.01
Off-Road		
Tier 1	6.9	0.40
Tier 2	4.3	0.15
Tier 3	2.6	0.15
Tier 4	0.3	0.015

Emission Standards for off-road engines rated between 175 hp and 750 hp

The following paragraphs describe three types of cargo handling equipment: yard trucks or hostlers, rubber tired gantry (RTG) cranes, and wide span gantry cranes.

Yard Trucks:

Yard trucks, also known as yard goats, utility tractor rigs, hustlers, yard trucks, and yard tractors, are the most common type of cargo handling equipment. Yard trucks are typically equipped with off-road engines but are very similar to heavy-duty on-road truck tractors. Cargo handling equipment, such as RTG cranes, load container cargo to and from yard trucks and trains. Yard trucks then move the container cargo around the railyard for stacking and storing purposes.

Yard Truck

Rubber Tired Gantry Cranes:

RTG cranes are very large cargo container handlers that have a lifting mechanism mounted on a cross-beam supported on vertical legs which run on rubber tires. While the propulsion of the crane is very slow (about three miles per hour), the lifting mechanism can move quickly, and is therefore able to load and unload containers from yard trucks or from stacks at a very fast pace. RTG cranes have a horsepower range of about 200 to 1,000 horsepower, with most being between around 300 to 1,000 horsepower. There are approximately 300 RTG cranes at California's ports and intermodal rail yards. Based on the 18 railyard HRAs, there are about 67 RTGs in eight intermodal railyards.

Rubber Tired Gantry (RTG) Cranes

Rail Mounted Gantry or Wide Span Gantry Cranes:

Wide span gantry (WSG) cranes travel on rails to lift and stack container cargo. Compared to RTG cranes, WSG cranes are wider, are driven by electrical power, and have a higher traveling speed while handling cargo. WSG cranes are not only larger but also faster than RTG cranes which allows them to process more container cargo faster and gives container handling facilities (like intermodal railyards) higher stacking densities and greater lift capacities. As WSG cranes are driven by electrical power, they are quieter than RTG cranes and also have no direct on-site emissions.

Wide Span Gantry (WSG) Cranes

U.S. EPA Tier 4 Non-Road Engine Regulation and the ARB Regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Railyards

In 2004, the U.S. EPA promulgated final emission standards for Tier 4 off-road diesel engines which are estimated to result in a 95 percent reduction in particulate matter emissions (PM) and a 90 percent reduction in oxides of nitrogen (NOx). The rulemaking affects engines manufactured after 2007 and uses a seven year phase-in period to implement the new emission standards. The new U.S. EPA emission standards are based on the use of advanced exhaust emission control devices such as diesel oxidation catalysts (DOC), selective catalytic reduction (SCR), and diesel particulate filters (DPF).

In 2005, the ARB took aggressive steps to mitigate emissions beyond the U.S. EPA off-road diesel emissions standards by approving a regulation for "Mobile Cargo Handling Equipment at Port and Intermodal Railyards." This regulation takes a two pronged approach to reduce emissions and breaks up cargo handling equipment into two basic categories: Yard Trucks (e.g., hostlers) and Non-Yard Trucks (e.g., cranes). Both categories are required to comply with the regulation through the best available control technology (BACT).

Yard trucks can contribute up to 70 percent of railyard CHE emissions. Non-yard truck equipment such as RTGs cranes and other types of container cranes can contribute up to 20 percent or more of railyard CHE emissions. Other CHE such as top picks, forklifts, and loaders contribute to the rest of railyard CHE emissions.

Older yard trucks or hostlers will meet this performance standard primarily by accelerated turnover to new yard trucks equipped with on-road engines meeting the 2007+ emission standards. Non-yard truck equipment will meet BACT performance standards either through new on-road, or off-road engines or through the use of engine retrofit and a second compliance step (Tier 4 off-road engine or Level 3 VDECS). The ARB regulation is estimated to reduce diesel PM and NOx emissions from all cargo handling equipment by up to 80 percent by 2020. The ARB regulation became effective on January 1, 2007. Table III-2 shows the estimated emission reductions from the ARB regulation relative to the estimated emissions for 2004.

Table III-2
Estimated NOx and PM Emission Reductions
(ARB Regulation for Mobile Cargo Handling Equipment at Port and Intermodal Railyards)

Pollutant	2010	2015	2020
NOx	35%	47%	77%
PM	52%	66%	82%

2. Summary of Potential Options to Reduce Emissions from Cargo Handling Equipment

For this assessment, ARB staff assessed six potential options to reduce emissions from yard trucks and RTG cranes. These options are summarized in Table III-3 and are referred to as options 9 through 14.

Table III-3: Potential Options to Reduce Emissions from Cargo Handling Equipment

No.	Options	PM (tons per day)	NOx (tons per day)	Cost-Effectiveness (NOx+PM)	Costs (millions)
Yard Trucks/Hostlers – (Replace 322 yard trucks in 8 intermodal railyards)					
10	LNG Yard Trucks	-	-	-	$39 ($.12/unit 322 units)
11	Electric Yard Trucks	0.01[1] (2015)	0.27[1] (2015)	$41/lb (2015) (8 years)	$68 ($.21/unit 322 units)
12	Hybrid Yard Trucks	-	-	-	-
RTG Cranes – (Retrofit/Replace 67 RTGs in 8 intermodal railyards)					
13	Energy Storage Systems	0.0014 (2015)	0.082 (2015)	$9-$18/lb (2015) (20 years)	$11-22 ($.16-$.32/ 67 RTG Cranes)
14	Wide Span Gantry Cranes and Non-Locomotive Railyard Electrication	0.023 (2015)	0.79 (2015)	$101/lb (2015) (20 years)	$1,200 (134 WSGs replace 67 RTGs)
Idle Reduction Devices - (Retrofit cargo handling equipment with idle reduction devices similar to those employed on trucks and locomotives)					
15	Idle Reduction (Cargo Handling Equipment)	-	-	-	-

1. Emission reductions are surplus to the ARB Regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Railyards in 2015.

Each option could provide further and earlier emission reductions than required by the ARB's existing cargo handling equipment regulation.

3. Analysis of Option 10 - LNG Yard Trucks at Railyards

<u>Background</u>

Alternative fuels are one of the many strategies that the ARB has employed to control emissions and reduce health risks from diesel engines. In heavy-duty diesel engines, liquefied natural gas (LNG) is one alternative to diesel fuel. LNG is a cryogenic liquid (boiling point: -260°F) and a form of natural gas that is not only denser, but also contains more energy per volume than most alternative fuels. However, compared with diesel fuel, the energy content of LNG is less (diesel is rated at about 130,000 Btu per gallon and LNG is rated at about 75,000 Btu per gallon). This a key consideration with LNG because LNG fueled vehicles can incur up to a 40 percent loss in energy content, as well as a potential loss in fuel efficiency, as compared to diesel on a gallon equivalent basis.

In order to transport and store LNG, with such a low boiling point, on-board fuel tanks require a double wall design with high grade insulation and vacuum inter-tank space. These requirements make LNG tanks more complex and heavier than traditional diesel fuel tanks. Accordingly, LNG fueled yard trucks carry a weight penalty absent in conventional diesel-fueled yard trucks.

Heavy-duty engines can either be originally manufactured to run on LNG or converted from diesel. Diesel engines can be converted to run on LNG fuel because they share many of the same components as heavy-duty LNG engines. The biggest differences between LNG and diesel engines are the compression ratio, fuel delivery, and ignition systems.

There are several conversion kits available which allow heavy duty diesel engines to be adapted to use LNG fuel, but the conversion usually comes with a tradeoff of derated power which avoids pre-ignition detonation of the gaseous fuel.

Technical Feasibility

LNG yard trucks are being evaluated through demonstration programs sponsored by the U.S. EPA, South Coast Air Quality Management District (SCAQMD), the Ports of Los Angeles and Long Beach, and others. In 2008, Sound Energy Solutions (SES) and the Port of Long Beach released a report detailing the findings of a joint project to determine performance, emissions, and business impacts of LNG yard trucks.

One potential issue surrounding the use of LNG fuel is the NOx emissions from LNG engines. Previous studies comparing on-road diesel to on-road LNG yard trucks, one conducted by ARB (2006) and one by the Port of Long Beach (2007), showed significantly higher NOx emissions from the LNG engines in comparison to the on-road diesel engines[3]. Emission testing conducted as part of the Port of Long Beach and SES LNG yard truck study also found that the LNG engines produced more NOx than the on-road diesel engines. The SES report also noted a decrease in fuel efficiency in comparison to the diesel-fueled yard trucks. ARB plans to conduct in-use emissions testing in 2009, comparing a diesel-fueled yard truck certified to 2007 on-road standards to an LNG-fueled yard truck certified to 2010 on-road standards.

The lack of an LNG fueling infrastructure also remains a challenge to LNG. In the SES study, the refueling station consisted of a 3,450 gallon ORCA™ mobile LNG refueling truck. The truck was inspected to verify conformance to local permitting and safety requirements and, for the study, treated as a permanent structure. Applied LNG Technologies was contracted to provide fuel deliveries for the project.

Potential Emission Reductions

The SES report compared three LNG-fueled yard trucks to a representative sample of diesel-fueled yard trucks powered by off-road and on-road engines meeting standards illustrated in Table III-1.

[3] Source: “Cargo Handling Equipment Yard Truck Emissions Testing”, CARB, September 2006; “Liquefied Natural Gas (LNG) Yard Hostler Demonstration and Commercialization Project – Prepared for the Port of Long Beach,” West Start-CALSTART, 2007

One key aspect to the ARB CHE Regulation is its fuel neutrality. New yard trucks must meet the 2007+ on-road or Tier 4 off-road engine standards for PM and NOx regardless of fuel type. Therefore, if LNG fueled yard trucks are compared to diesel fueled yard trucks powered by 2007+ on-road or Tier 4 off-road engines, they provide no surplus emission reductions to the ARB CHE regulation in 2015.

Costs

According to 2008 SES and the Port of Long Beach report, the estimated cost of an LNG yard truck is about $120,000 per unit. The SES report also estimated that the cost of a LNG fueling station at around $700,000, but ARB staff did not include the fueling infrastructure costs as it was not clear how many LNG trucks could be supported by an individual LNG fueling station. In comparison, diesel fueled yard trucks are estimated to cost between $50,000 and $60,000 per unit.

Cost-Effectiveness

Cost-effectiveness for LNG yard trucks was not calculated because staff was not able to identify emission reductions that are surplus to the ARB CHE regulation in 2015.

4. Analysis of Option 11 - Electric Yard Trucks in Railyards

Background

Electric yard trucks use onboard batteries which produce electricity to run an electric motor. Electric yard trucks have zero emissions onsite, but need an external charging station to recharge their batteries. This technology has been demonstrated on vehicle platforms ranging from passenger vehicles to trucks. Electric yard trucks are currently being tested at the Port of Los Angeles to demonstrate the technical feasibility of this technology in port applications.

Technical Feasibility

Electric yard trucks are being evaluated through demonstration programs sponsored by the U.S. EPA, SCAQMD, the Ports of Los Angeles and Long Beach, and others. In 2008 the Port of Los Angeles began testing and demonstrating an electric yard truck for several parameters critical to port applications, including payload and range. As a result of this demonstration effort, the Los Angeles Harbor Commission recently approved an order for the production of 20 electric yard trucks, pending the successful completion of cargo terminal tests. According to the manufacturer, Balqon, these electric yard trucks are capable of towing up to 30 tons, have a maximum speed of 25 miles per hours, and a range of 30 miles when under full load.

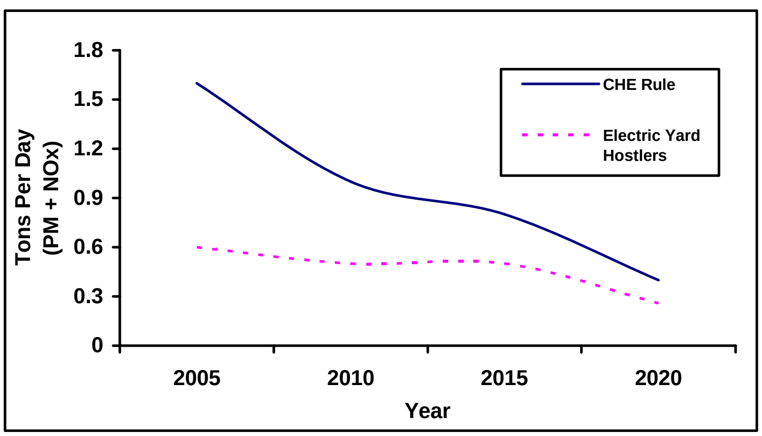
Potential Emission Reductions

ARB staff compared the individual emissions of an electric yard truck to a conventional yard truck powered by a 2007+ on-road diesel engine (PM: 0.01 g/bhp-hr, NOx: 0.3 g/bhp-hr). ARB staff estimated that on a per unit basis, electric yard trucks provide potential diesel PM and NOx emission reductions of 0.000005 and 0.00016 tons per day, respectively.

According to the 18 railyard HRAs, in 2005, the 322 yard trucks operated at eight intermodal railyards generated an estimated 0.041 and 0.90 tons per day of diesel PM and NOx emissions, respectively. As a result of the ARB CHE regulation, staff estimates that by 2020 diesel PM and NOX emissions, associated with yard trucks, could be as low as 0.005 and 0.082 tons per day respectively.

Staff estimates that electric yard trucks could reduce railyard diesel PM and NOx emissions from yard trucks by up to 100 percent. These emission reductions would be surplus to the to the ARB CHE regulation, as well as the U.S. EPA/ARB Tier 4 non-road engine regulation and result in diesel PM and NOx reductions of up to 0.015 and 0.46 tons per day, in 2010, respectively. In 2015, as diesel engines become cleaner, the level of diesel PM and NOx reductions that electric yard trucks could achieve drops to 0.01 and 0.27 tons per day, respectively. Figure III-1 shows the projected railyard CHE emission reductions from electric yard trucks.

Figure III-1: CHE Railyard Emissions –
Projected Emission Benefits of Electric Yard Trucks



Costs

According the Port of Los Angeles Electric Truck Demonstration Fact Sheet, electric yard trucks cost approximately $189,950 per unit. The fact sheet also states that the price of one charging station (which simultaneously charges four trucks) is about $75,000. It is not clear whether the charging station cost also includes the cost of construction or additional infrastructure needed to support this technology. Allocating the cost of the charging station to an electric yard truck increases the cost to about $209,000 per piece of equipment. In comparison, diesel fueled yard trucks are estimated to cost between $50,000 and $60,000 per unit.

Cost-Effectiveness

Staff has calculated cost-effectiveness for electric yard trucks to be about $41 per pound of NOx and PM emissions reduced. This is based on the estimated railyard yard truck emission levels of diesel PM and NOx in 2015, as a result of the ARB cargo handling regulation. As stated previously, this estimate does not account for the cost of the electric infrastructure.

5. Analysis of Option 12 - Hybrid Yard Trucks in Railyards

Background

Hydraulic hybrid yard trucks are vehicles that, in addition to their main engines, have a drive train that can recover, store, and reuse energy. In a hydraulic hybrid, the hydraulic drive system uses hydraulic accumulators and converts stored energy with hydraulic pump motors. This hydraulic drive system replaces a conventional drive train and eliminates the need for a conventional transmission.

The hydraulic hybrid system increases vehicle fuel economy in three ways by:
1) permitting the recovery of energy that is otherwise wasted in vehicle braking,
2) allowing the engine to be operated at much more efficient modes, and 3) enabling the engine to be shut-off during many operating conditions, such as when the vehicle is decelerating and momentarily stopped.

Technical Feasibility

Hybrid yard trucks are being evaluated through demonstration programs sponsored by the U.S. EPA, the Ports of Los Angeles and Long Beach, and others. In 2005, the U.S. EPA and United Parcel Service (UPS) unveiled a demonstration delivery van with a hydraulic hybrid drive-train. The demonstration van uses a series hydraulic hybrid system which transmits power directly to the wheels rather than through a conventional transmission or drive shaft. Early test results show a potential for up to a 45 to 50 percent improvement in fuel economy in city driving.

Based on the results of the early tests, U.S. EPA and the Port of Long Beach commenced a hydraulic hybrid yard truck demonstration project. The goal of this demonstration program is to build a prototype so that common requirements could be established for a hybrid yard truck duty cycle. The results of this demonstration are still pending. ARB is planning to support this demonstration project through in-use comparison emissions testing with a 2007+ conventional diesel yard truck. Testing is expected to occur in 2009.

Potential Emission Reductions

Staff was unable to develop estimates of hybrid yard trucks potential emission reductions. Any emission reductions would most likely result from increases in fuel economy indicated throughout initial testing. During ARB's planned emissions testing next year, in-use data logging will be performed on the hybrid engine and an appropriate duty cycle will be developed and used for the comparison tests.

Costs

Staff does not currently have cost information for hybrid yard trucks. However, following the UPS demonstration, U.S. EPA estimated that in high-volume production (20,000 to 30,000 units per year), the incremental cost difference would be about $10,000 compared to a conventional diesel truck for the same application.

Cost-Effectiveness

Staff did not calculate cost-effectiveness for hybrid yard trucks due to the lack of costs and emissions reductions data.

6. Analysis of Option 13 - Energy Storage Systems on Railyard RTG Cranes

Background

Energy Storage Systems (ESS) capture regenerated energy from energy that would otherwise be dissipated and lost from crane braking, deceleration, etc. In crane applications, an ESS is integrated with a hoist motor, and the dissipated (lost) energy is captured (regenerated) from the hoist cycle. As the crane lowers a container, the hoist motor acts as a generator (through regenerative braking energy, a result of deceleration). Typically, this energy is routed to dissipating resistor banks and wasted as heat. The ESS captures this energy and uses it to reduce the load of an engine throughout the duty cycle.

Technical Feasibility

ESS systems are currently available for several off-road engines. These systems are considered a Level 1 VDECS for RTG crane applications. A level 1 VDECS reduces diesel PM by up to 25 percent, however, ESS can also reduce NOx emissions by 25 percent as well[4].

Potential Emission Reductions

ARB staff calculated the emission benefits of an ESS retrofit on a RTG crane powered by a Tier 4 off-road diesel engine (PM: 0.01 g/bhp-hr, NOx: 0.3 g/bhp-hr). ARB staff

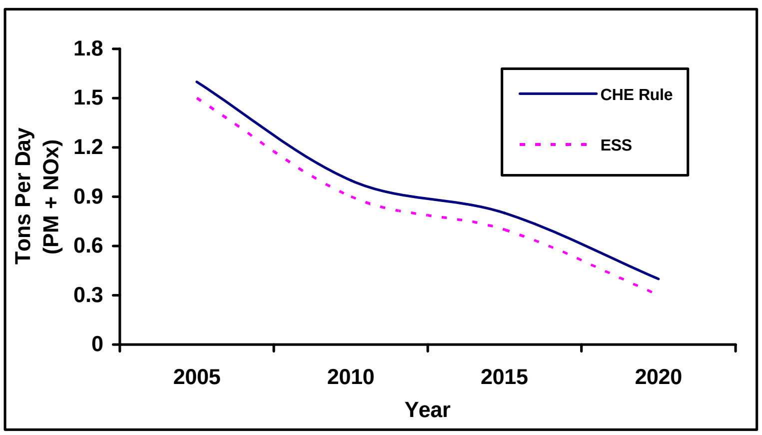
[4] http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm

estimated that an individual ESS unit can provide diesel PM and NOx emission reductions of up to 0.002 and 0.04 tons per year, respectively.

According to the 18 railyard HRAs, in 2005, the 67 RTG cranes operated at eight intermodal railyards generated an estimated 0.014 and 0.40 tons per day of diesel PM and NOx emissions, respectively. As a result of the ARB CHE regulation, staff estimates that by 2020 diesel PM and NOX emissions, associated with RTG cranes, could be as low as 0.005 and 0.27 tons per day respectively.

Staff estimates that ESS could reduce railyard diesel PM and NOx emissions from RTG cranes by up to 25 percent. These emission reductions would be surplus to the ARB CHE regulation as well as the U.S. EPA/ARB Tier 4 non-road engine regulation. In 2010, the ESS could provide diesel PM and NOx reductions of up to 0.002 and 0.093 tons per day respectively. In 2015, as diesel engines become cleaner, the level of diesel PM and NOx reductions that ESS could achieve drops to 0.001 and 0.082 tons per day, respectively. Figure III-2 shows the resulting railyard CHE emission benefits from retrofitting RTG cranes with ESS.

Figure III-2: CHE Railyard Emissions – Projected Emissions Reduction of ESS on RTG Cranes



Costs

An ESS is estimated to cost between \$160,000 and \$320,000 per crane[5]. For the eight intermodal railyards with 67 RTG cranes, the total costs would range between \$11 and \$22 million.

[5] Source: "Proposition 1B: Goods Movement Emission Reduction Program, Final Guidelines for Implementation" – February, 2008.

Cost-Effectiveness

Cost-effectiveness for ESS ranges between an estimated $9 and $18 per pound of NOx and PM emissions reduced. Cost effectiveness is based primarily upon the estimated cost range for ESS, and the estimated railyard RTG crane emission levels of diesel PM and NOx in 2015, as a result of the ARB cargo handling regulation.

7. Analysis of Option 14 – Use of Railyard Wide Span Gantry Cranes and Non-Locomotive Railyard Electrification

Background

One alternative to traditional RTG cranes are wide span gantry (WSG) cranes and installation of the necessary electrific infrastructure to support WSG cranes. Railyard electrification and the installation of WSG cranes could nearly eliminate all RTG crane and yard truck railyard-related emissions.

WSG cranes are powered by electricity generated by the electrical grid (rather than a diesel engine). WSG cranes are twice as wide as conventional RTG cranes and are rail mounted. In contrast to RTG cranes, WSG cranes can be semi-automated because they employ advanced computer and GPS systems.

Technical Feasibility

Generally, WSG crane systems are implemented at brand new or key port and railyard facilities designed to handle a large volume of containers (i.e, more than 750,000 per year). BNSF has installed WSG cranes at the BNSF Seattle International Gateway facility located at the Port of Seattle. BNSF has also proposed installing WSG cranes at other key intermodal facilities in Memphis and Kansas City.

Union Pacific has proposed to modernize the Intermodal Container Facility (ICTF) in Long Beach, California. UP has proposed to install 39 WSG cranes in three phases over three years. The proposed expansion would replace 10 existing RTGs, with 20 WSG cranes. In addition, UP has proposed to install an additional 19 WSG cranes to accommodate the proposed doubling of container handling, which would increase from the current 750,000 to 1,500,000 lifts.

Installation of WSG cranes carry widely varying costs associated with planning and construction and the operational needs of an individual facility. There is no one route to electrification at a railyard. Every facility is different, and projects of this magnitude require extensive planning. The type of electric equipment which may be operationally feasible at one yard may not be operationally feasible at another railyard. Furthermore, electrification may not necessarily result in zero emissions. Some facilities may still need to use diesel-fueled CHE, such as side loaders, top picks, and forklifts, to complement the all-electric equipment.

Potential Emission Reductions

According to the 18 railyard HRAs, in 2005 the 322 yard trucks and 67 RTG cranes operated at eight intermodal railyards generated nearly all of the 0.07 and 1.49 tons per day of railyard CHE diesel PM and NOx emissions, respectively. As a result of the ARB CHE regulation, staff estimates that by 2020 diesel PM and NOX emissions, associated with railyard CHE, could be as low as 0.014 and 0.30 tons per day, respectively. Table III-4 compares diesel PM and NOx emissions for eight intermodal railyards in 2005 and 2020.

Table III-4
Eight Intermodal Railyards - 2005 and 2020 CHE Emissions

Railyard	**2005 CHE Emissions (tons per day)**		**Estimated 2020 CHE Emissions (tons per day)**	
	PM	**NOx**	**PM**	**NOx**
UP Commerce	0.013	0.13	0.003	0.026
UP ICTF	0.012	0.33	0.0024	0.066
BNSF Hobart	0.011	0.34	0.0023	0.068
BNSF San Bernardino	0.01	0.32	0.002	0.065
UP City of Industry	0.008	0.1	0.0015	0.02
UP LATC	0.007	0.16	0.0014	0.032
UP Oakland	0.005	0.06	0.0011	0.013
BNSF Commerce Eastern	0.001	0.04	0.0002	0.008
Total	**0.067**	**1.48**	**0.0139**	**0.298**

Staff has assumed a best case scenario, that the electrification of a railyard and the installation of WSG cranes would eliminate all CHE emissions in the eight intermodal railyards. This options's emission reductions would be surplus to the ARB CHE regulation and the U.S. EPA/ARB Tier 4 non-road engine regulation. This option could result in diesel PM and NOx reductions of up to 0.033 and 0.97 tons per day in 2010, respectively. In 2015, as diesel engines become cleaner, the level of diesel PM and NOx reductions that WSG cranes and railyard electrification could achieve drops to 0.023 and 0.79 tons per day, respectively.

Costs

WSG cranes can cost between $4 and $8 million per crane (depending on size, configuration, application, etc.). However, as was stated previously, WSG cranes, along with their base costs, can incur other costs (i.e., planning and construction) that can vary widely. Electric infrastructure and related construction costs needed to support WSG cranes can be more than double the costs of the WSG cranes. Table III-5 lists cost estimates of WSG crane and railyard electrification for eight intermodal railyards.

Table III-5
Estimated Railyard Electrification and Wide Span Gantry Costs For Eight Intermodal Railyards

Eight Intermodal Railyards	Estimated 2005 Container Lifts	Estimated RY Electrification* and WSG Costs ($ million)
BNSF Hobart	1,500,000	400
UP ICTF	750,000	200
BNSF San Bernardino	500,000	150
UP Commerce	350,000	100
UP LATC	350,000	100
UP Oakland	350,000	100
UP City of Industry	350,000	100
BNSF Commerce/East.	130,000	40
Totals	4,280,000	1,190

*Non-Locomotive

As Table III-4 shows, in 2005 eight intermodal railyards performed 4,280,000 container lifts. In order to perform comparable work, nearly 134 WSG cranes would need to be installed across the eight railyards. Staff has estimated that the cumulative costs of the WSG cranes at eight intermodal railyards as well as the necessary electric infrastructure could approach $1.2 billion.

Cost-Effectiveness

Staff has calculated cost-effectiveness for non-locomotive railyard electrification and WSG cranes to be about $101 per pound of diesel PM and NOx emissions reduced. Cost effectiveness is based on the estimated railyard CHE emission levels of diesel PM and NOx in 2015, as a result of the ARB cargo handling regulation.

7. Analysis of Option 15 – Reducing Idling for Railyard CHE

Background

Idle reduction technologies were initially developed to mitigate emissions associated with non-essential idling from locomotive and truck engines. Most idle reduction systems are passive and automate shutdown/restart sequences by monitoring and maintaining essential parameters that are needed for the operational or safety purposes (i.e., powering heating units in cold climates) of this equipment without any input from the operator. Currently, there are several idle reduction technologies available for locomotives and heavy duty diesel trucks. These technologies include: automatic shutdown/ startup systems, auxiliary power units, fuel operated heaters, and battery air conditioning.

Automatic shutdown/startup systems (referred to as AESS) for locomotives work by managing the shutdown and restart sequences of a locomotive engine while the locomotive is stopped. The system monitors the existing condition of several essential criteria (i.e. brake cylinder pressure, battery voltage, throttle position, etc.) against preset standards and determines whether the engine can be shut down or if it needs to be restarted. In trucks, the AESS system works in a similar fashion.

Auxiliary power units (APU) are small engines that work to reduce engine idle by shutting down the main (larger) engines of locomotives and trucks. As with automatic shutdown/startup systems, these units also monitor essential engine systems against set criteria. APUs, however, can also provide power for the heating and air conditioning units in the locomotive or truck cab.

Fuel operated heaters (FOH) and battery air conditioning (BAC) both work to reduce engine idle by providing power to a cab's heating and air conditioning system, allowing the main engine to be shut-down.

Most idle reduction technologies were not initially designed for cargo handling equipment. While shutdown/startup systems have been effective at reducing emissions from idling trucks and locomotives, it is not clear what, if any, emission reductions these systems can provide from cargo handling equipment.

Anti-idling policies at intermodal railyards may also effectively reduce emissions from CHE. Limiting unnecessary idling will result in reduced fuel usage, a reduction of criteria pollutants, and a fuel cost savings.

Technical Feasibility

Idle reduction device technology for cargo handling equipment is not currently available nor is it being demonstrated. Additionally, there is currently no regulation prohibiting unnecessary idling from CHE. It has not yet been determined to what extent CHE may idle unnecessarily. Further research is needed to address CHE adaptability with idle reduction devices, to identify potential opportunities for emission reductions (i.e., extended idling periods within the duty cycle), and analyze railyard cost-effectiveness and operational and business technical feasibility. Safety issues related to turning engines off while equipment is awaiting use also needs to be thoroughly studied.

Potential Emission Reductions

At this time there is no proven idle reduction technology for cargo handling equipment. However, the emission reductions achieved would depend on the amount of unnecessary idling that exists and is reduced. Any emission reductions would be surplus to the ARB CHE regulation.

Costs

At this time staff does not have any actual costs for idle reduction devices on CHE.

Cost-Effectiveness

ARB staff does not currently have actual emission reductions and costs data for idle reduction devices on CHE. As a result, staff has not calculated cost-effectiveness.

B. Transportation Refrigeration Unit (TRU) – Plug-In Electrification

1. Background

TRUs are typically powered by small nonroad diesel engines of usually less than 50 horsepower. TRU diesel engines power compressors that regulate the temperature inside a cargo container or refrigerated railcar. They are primarily used to ensure that temperature sensitive cargo, such as food, is kept at an acceptably low temperature while in transit.

In February 2004, the Board approved a regulation for "In-Use Diesel Fueled Transport Refrigeration Units" (TRU) and TRU generator (gen) sets, and facilities where TRUs operate. The existing TRU regulation was approved by the Office of Administrative Law on December 10, 2004. Implementation begins December 31, 2008 and is phased-in over about 15 years. Note, however, that the U.S. EPA has not yet granted a waiver for this regulation. As a result, the ARB staff has issued guidance that indicates that the regulation will be enforced six months after issuance of the waiver. The goal of the TRU regulation is to reduce diesel particulate matter from TRUs that operate in California by about 92 percent by 2020.

In 2005, the ARB emission inventory estimated that statewide TRUs accounted for about 2.5 tons per day (or 913 tons per year) of diesel PM and 24 tons per day of NOx. According to the ARB railyard HRAs, TRU diesel PM emissions were an estimated 0.04 tons per day, or about 14 tons per year, within California's 18 designated railyards in 2005. Within the eight intermodal railyards, TRUs accounted for about 13 tons per year in 2005. Total railyard TRU diesel PM emissions represent nearly 2 percent of statewide TRU diesel PM emissions.

Staff has prepared a technical assessment of an option that would be in addition to the ARB TRU regulation. This option is to include plug-in electrification for TRUs, to further reduce diesel PM emissions from TRUs at railyards.

2. Analysis of Option 16 – Plug-In Electrification for Transport Refrigeration Units (TRUs)

Technical Feasibility

Plug-in electric power is currently technically feasible and commercially available. For example, plug-in TRU electrification has been installed in the Port of Oakland. Land must be dedicated for this equipment and electrical infrastructure must be installed to utilize plug-in TRU electrification. For the Port of Oakland, the plug-in electrification equipment are located at either a parking lot where containers are placed on chassis and serviced by dedicated electrical outlets, or on a structure called a reefer rack where containers are stacked and plugged in.

Reefer Rack

Currently, there are no railyards in California with TRU plug-in electric power. In order to incorporate plug-in electric power for TRUs, railyards would have to dedicate areas within the railyards, like the Port of Oakland, and install the necessary reefer racks and electrical infrastructure. Installation of electrical infrastructure would be necessary due to the high power draw of the TRUs when plugged in, especially during peak shipping periods such as the summer harvest. The necessary electrical infrastructure would likely be comparable to that currently planned for installation in the UP ICTF modernization plan. TRU plug-in electrification would likely be most effective if included as part of a larger railyard electrification project.

Plug-in electric power would have the greatest impact in the railyards with the highest TRU diesel PM emissions. Note that electric plug-in for TRUs would be compatible with TRU standalone containers, but not with refrigerated railcars.

Potential Emissions Reductions

In 2005, the eight intermodal railyards generated about 13 of the 14 tons per year of diesel PM emissions associated with TRUs. The eight intermodal railyards include: BNSF Hobart, BNSF San Bernardino, BNSF Commerce Eastern, UP ICTF, UP Oakland, UP Commerce, UP City of Industry, and UP LATC.

The ARB TRU regulation is expected to reduce TRU emissions by 92 percent by 2020 in the 8 intermodal railyards (accounting for growth) or to about 0.003 tons per day, or about 1 ton per year, of railyard TRU diesel PM emissions. Therefore, the maximum possible emissions reductions in the four largest railyards would be about 0.003 tons per day of diesel PM by 2020.

TRU NOx is generally emitted at a factor of 10 times higher than PM emissions. To estimate the NOx emission reductions, the PM emission reductions were multiplied by 10. The maximum mitigated NOx would therefore be about 0.03 tons per day by 2020 using this method.

Due to the increased usage of yard trucks to transport the TRUs from rail to racks and back, there is a possibility that this option could also lead to no emission reductions or possibly lead to emissions increases. The amount of increased emissions is not known. Further study would be necessary before implementation of this option to assess all of the potential impacts. However, accelerated implementation of this option would increase the emission benefits.

Costs

Costs of the refrigerated or reefer racks have been estimated to be about $120,000 to $216,000 per rack, based on bids received at the Port of Oakland. Based on these estimates, staff assumed total costs of $1 million to install racks at eight intermodal railyards. The installation of reefer racks would necessitate installation of additional electrical infrastructure which could cost up to $500 million or more. However, non-locomotive railyard electrification costs for eight intermodal railyards would cost an estimated $1.2 billion to be able to support the TRU plug-in electrification.

Cost-Effectiveness

This option assumes that 100 percent of the remaining 0.003 tons per day of diesel PM emissions and 0.03 tons per day of NOx in 2020 are completely eliminated. The costs have been amortized over 10 years. Based on these assumptions, the cost-effectiveness for this option would be about $4.2 million per ton, or about $2,100 per pound of PM and NOx reduced.

C. Port and Intermodal Railyard Drayage Trucks

1. Background

A heavy-duty drayage truck is any on-road diesel-fueled vehicle with a gross vehicle weight rating (GVWR) of 33,001 pounds or greater. Drayage trucks operate primarily in and around ports and intermodal railyards. Drayage trucks transport cargo, such as containerized, bulk or break–bulk goods. Staff estimates that approximately 20,000 drayage trucks annually operate on a regular basis at California’s ports and intermodal railyards. Of that total, approximately 16,800 drayage trucks frequently operate at the Ports of Los Angeles and Long Beach.

Drayage trucks are a significant source of air pollution. In 2007, drayage trucks generated an estimated 3 and 61 tons per day of diesel PM and NOx, respectively. Drayage trucks also often operate in close proximity to communities. In December 2007, the ARB Board approved a port truck fleet modernization program that, as compared to the 2007 emission inventory baseline, will reduce diesel PM by nearly 86 percent by 2010, and NOx by nearly 56 percent by 2014. The ARB port and intermodal railyard drayage truck regulation will result in significant reductions in exposure and potential cancer risks to residents that live near ports, railyards, and the major roadways that service the ports and intermodal railyards.

ARB staff has assumed, for both emissions reductions and cost-effectiveness calculations, all intermodal railyards will meet the ARB drayage truck regulation requirements by January 1, 2014. This would result in all intermodal railyard drayage trucks meeting a 1.2 g/bhphr for NOx and 0.01 g/bhp-hr for PM by at least 2015. ARB staff assumes that the ARB drayage truck regulation will serve as the emissions baseline to compare with LNG, CNG, and electric drayage trucks in 2015.

Health risk assessments were prepared for 18 major railyards, with 8 of those railyards identified as intermodal. In 2005, within the boundaries of the 8 intermodal railyards drayage trucks generated about 0.085 tons per day (31 tons per year) of diesel PM emissions. The eight intermodal railyard drayage truck diesel PM emissions account for about 3 percent of statewide drayage truck PM emissions. The ARB drayage truck regulation is estimated to reduce intermodal railyard drayage truck diesel PM emissions by up to 90 percent by 2015, or to about 0.0085 tons per day (3.1 tons per year) of diesel PM emissions.

ARB staff estimates that the emerging alternative fuel technologies for drayage trucks (e.g., CNG, LNG, and electric), may potentially provide additional emission reductions for intermodal railyards beyond those required by the ARB port and intermodal railyard drayage truck regulation by 2015.

2. Analysis of Option 17 – New 2007 Diesel Fueled Drayage Trucks Within Intermodal Railyards

Background

The ARB port and intermodal railyard drayage truck regulation has been approved by Office of Administrative Law and will go into effect by January 1, 2009. Drayage trucks entering ports and intermodal railyards will be required to generally meet new 2007 PM truck standards (i.e., built with or retrofitted with a diesel particulate filter) and meet 0.01 g/bhp-hr, except for a smaller group of newer trucks, by January 1, 2010. On a fleet average basis, ARB staff estimated an 86 percent reduction in drayage truck PM emissions by January 2010, and up to a 90 percent reduction in PM emissions by 2014.

Similarly, port and intermodal railyard drayage truck NOx emissions will be limited to the new 2007 truck emissions levels of 1.2 g/bhp-hr (average) by January 1, 2014. The

ARB drayage truck regulation NOx requirement will result in about a 56 percent NOx reduction on a fleet average basis by 2014. The intermodal railyards will also benefit from any new 2010 trucks (NOx at 0.2 g/bhp-hr) that enter the intermodal railyards as well.

Potential Emissions Reductions

Health risk assessments were prepared for 18 major railyards, with eight of those railyards identified as intermodal. In 2005, within the boundaries of the eight intermodal railyards drayage trucks generated about 0.085 tons per day, or 31 tons per year, of diesel PM emissions. The eight intermodal railyard drayage truck diesel PM emissions account for about 3 percent of statewide drayage truck PM emissions. The ARB drayage truck regulation is estimated to reduce intermodal railyard drayage truck diesel PM emissions by up to 90 percent by 2015, or to about 0.0085 tons per day (3.1 tons per year) of diesel PM emissions.

Table III - 6
Older Existing HD Diesel Truck and New HD Diesel Truck
NOx and PM Emissions Standards

Existing Older Heavy-Duty (HD) Diesel and LNG Truck Model-Year	NOx (g/bhp-hr)	PM (g/bhp-hr)	NOx Reduced from 1995 MY	PM Reduced from 1995 MY
1995 Trucks	5.0	0.1	-	-
New 2007 HD Diesel Trucks	1.2	0.01	76%	90%
New 2010 HD Diesel Trucks	0.2	0.01	96%	90%
ARB Drayage Truck Regulation * **(2010 PM/2014 NOx)**	**1.2**	**0.01**	**76%**	**90%**

* Between 2007 and 2009 U.S. EPA requires 50 percent of the heavy-duty diesel engine family certifications to meet the 0.20 g/bhp-hr NOx standard. Averaging is allowed and it is expected that most engines will conform to the fleet NOx average of approximately1.2 g/bhp-hr.

The Port of Los Angeles (white paper) assumed that the average port drayage truck is a 1995 model year. The ARB Goods Movement Calculation assumes 1995 model year port drayage trucks travel about 40,000 miles per year. A 1995 model year HD diesel truck has NOx and PM grams per mile emissions rates of about 21 and 0.7, respectively, or about 1 ton per year for both NOx and PM.

ARB staff has assumed a new 2007 truck NOx and PM emissions levels (i.e., 5 grams/mile NOx and 0.07 grams/ mile PM) as the baseline for 2014, based on the ARB drayage truck regulation. A new 2007 HD diesel truck would generate about 446 pounds of NOx (440 lbs) and PM (6 lbs) per year. Therefore, a 2007 diesel drayage truck replacement, as required by the ARB drayage truck regulation by 2015, would provide no surplus NOx and PM emissions reductions beyond existing ARB truck regulations applicable to intermodal railyards.

Costs

The Port of Los Angeles (white paper) estimated the cost of a new 2007/2010 HD diesel truck to be about $110,000.

Cost-Effectiveness

Assuming there are no emissions reductions when comparing 2007 HD diesel trucks with new 2007 HD diesel trucks, as required by the ARB drayage truck regulation by 2014. Therefore, there is no cost-effectiveness calculation for new 2007 HD diesel trucks.

3. Analysis of Option 18 – Liquefied Natural Gas (LNG) Fueled Drayage Trucks Within Intermodal Railyards

Background

The ARB port and intermodal drayage regulation defines “Liquid Natural Gas (LNG) Fueled Trucks” as drayage trucks that utilize a heavy-duty pilot ignition engine that is designed to operate using an alternative fuel, such as LNG, except that diesel fuel is used for pilot ignition at an average ratio of no more than one part diesel fuel to ten parts total fuel on any energy equivalent basis. An engine that can operate or idle solely on diesel fuel at any time does not meet this definition.

ARB staff examines the scenario of possibly replacing 2007 compliant diesel drayage trucks with new LNG fueled drayage trucks that will operate primarily from the ports to near dock intermodal railyards.

Technical Feasibility

LNG drayage trucks are being evaluated through various demonstration programs and projects sponsored by the U.S. EPA, South Coast Air Quality Management District (SCAQMD), the Ports of Los Angeles and Long Beach, and others. The Ports of Los Angeles and Long Beach, in collaboration with SCAQMD, California Energy Commission, Clean Energy, Kenworth Truck Company and Westport are working on the development and certification of a 2007 LNG high-pressure direct-injection engine. This effort will work to determine performance, emissions and business case impacts of the LNG truck engine. LNG drayage trucks are technically feasible, thoroughly tested, and are commercially available through the Kenworth Truck Company.

Figure III-3. LNG Drayage Truck by Kenworth Truck Company

Potential Emission Reductions

In 2005, within the eight intermodal railyards boundaries (with railyard HRAs), heavy-duty (HD) diesel trucks were responsible for an estimated 31 tons per year of diesel PM emissions. The ARB has three statewide diesel truck regulations for new, drayage, and private fleet trucks. However, the ARB drayage truck regulation will have the largest impacts in the near-term at intermodal railyards. ARB staff estimates that the ARB port and intermodal railyard drayage truck regulation will reduce diesel PM emissions by up to 90 percent by 2015, or to about 3.1 tons per year. New LNG heavy duty (HD) trucks could potentially provide earlier and greater emissions reductions beyond the emissions reductions provided by the ARB drayage truck regulation in 2015.

The Ports or Los Angeles and Long Beach have about 16,800 drayage trucks operating at their facilities. On average, the port's drayage trucks are 1995 model year trucks emitting at about 5.0 g/bhp-hr NOx and 0.1 g/bhp-hr PM. However, under the ARB drayage truck regulation, the older diesel trucks will be replaced or required to meet the 2007 new truck PM emissions standard of 0.01 g/bhp-hr (90% reduction) by January 1, 2010, and the 2007 new truck NOx emissions standard of 1.2 g/bhp-hr (75% reduction) by January 1, 2014. See the applicable truck emission standards below in Table III-7. With an average 90 percent reduction, the eight intermodal railyards diesel drayage truck diesel PM emissions could be reduced from 31 to about 3.1 tons per year by 2020.

As a result, the new 2007 HD diesel trucks, required by the ARB drayage truck regulation by 2010 and 2014, provide about the same level of PM and nearly the same levels of NOx emissions reductions as LNG HD trucks. With a reasonable compliance margin below the NOx standard, new 2007 HD diesel trucks may provide about equivalent NOx emissions reductions as current LNG HD trucks. However, staff has assumed that LNG HD trucks will provide a NOx benefit of about 33 percent.

Table III - 7
HD Diesel Truck and LNG Truck
NOx and PM Emissions Standards

HD Diesel and LNG Truck Model-Year	NOx (g/bhp-hr)	PM (g/bhp-hr)	NOx Reduced 1995 MY	PM Reduced 1995 MY
1995 Trucks	5.0	0.1	-	-
New 2007 Trucks	1.2 **	0.01	76%	90%
New 2010 Trucks	0.2	0.01	96%	90%
ARB Drayage Truck Regulation (2010 PM/2014 NOx)	**1.2**	**0.01**	**76%**	**90%**
LNG	0.8*	0.01*	84%	90%

* LNG certified emission rates.
** Diesel in-use and actual NOx emissions may be equivalent to LNG.

The Port of Los Angeles (white paper) assumed that the average port drayage truck is a 1995 model year. The ARB Goods Movement Calculation assumes 1995 model year port drayage trucks travel about 40,000 miles per year. A 1995 model year HD diesel truck has NOx and PM grams per mile emissions rates of about 21 and 0.7, respectively, or about 1 ton per year for both NOx and PM.

ARB staff has assumed a new 2007 HD diesel truck NOx and PM emissions levels (i.e., 5 grams/mile NOx and 0.07 grams/ mile PM) as the baseline for 2014, based on the ARB drayage truck regulation. A new 2007 HD diesel truck would generate about 446 pounds of NOx (440 lbs) and PM (6 lbs) per year.

An LNG HD replacement would provide emissions reductions, beyond those required by the ARB drayage truck regulation by 2015, for NOx only at about 33 percent. A 33 percent NOx reduction would provide about 146 pounds per year of NOx emissions reductions, beyond the current ARB drayage truck regulation by 2015.

<u>Costs</u>

The Port of Los Angeles (white paper) estimated the cost of a new LNG HD drayage truck to be about $210,000. A new 2007/2010 HD truck was estimated to cost about $110,000. The estimated additional cost for a new HD diesel truck to be built with a LNG fuel system (Cummins Westport, 2007) is estimated to be about $80,000.

The Port of Los Angeles estimated the cost for new LNG fueling tanks to be $5 million each. ARB staff has estimated that capital costs for a LNG fuel dispensing station are an estimated $800,000. Staff was advised that approximately 4 stations are needed to fuel 1,000 trucks, which is equivalent to a cost of $3,200,000 per 1,000 trucks, or about $3,200 per truck. ARB staff chose not to include LNG fueling infrastructure costs for this analysis.

Cost-Effectiveness

With capital costs of about $210,000, and assuming a 15-year useful life, the LNG HD truck replacement cost-effectiveness would be about $96 per pound of NOx reduced. Assuming only the cost difference between a new HD diesel drayage and LNG HD truck of about $100,000 (i.e., $210,000-$110,000), the cost-effectiveness would lower to about $46 per pound of NOx reduced.

4. Analysis of Option 19 – Compressed Natural Gas (CNG) Fueled Drayage Trucks Within Intermodal Railyards

Background

CNG trucks are powered by compressed natural gas. To provide adequate driving range, CNG must be stored onboard a vehicle in tanks at high pressure—up to 3,600 – 4,000 psi (pounds per square inch). A CNG-powered vehicle gets about the same fuel economy as a conventional gasoline vehicle on a gasoline gallon equivalent (GGE) basis.

Unlike diesel-powered trucks, CNG trucks have a shorter driving range due to fuel storage limitations. This option examines replacing the current average drayage truck fleet (1995 model year fleet) with new CNG fueled drayage trucks that will operate primarily from the ports to near dock intermodal railyards.

This option would have the greatest potential impacts at near dock railyards, such as UP ICTF, proposed BNSF SCIG, UP Oakland, and BNSF Oakland International Gateway (OIG). CNG trucks may also have potential range to operate to regional inland areas – such as the Inland Empire.

Technical Feasibility

The ports of Los Angeles-Long Beach recently launched a 12-month demonstration of CNG-fueled drayage trucks in December 2008 (see Figure III-4). The CNG HD drayage trucks are certified at 0.1 g/bhp-hr for NOx, which meets and exceeds the stringent 2010 NOx on-road truck emission standards of 0.2 g/bhp-hr. However, it is possible with a reasonable compliance margin, new 2010 HD diesel trucks may have actual in-use NOx emissions levels of about 0.01 g/bhp-hr similar to the CNG drayage trucks. The CNG drayage trucks also meet the new 2007-2010 on-onroad truck PM emissions standards of 0.01 g/bhp-hr.

Four heavy-duty CNG trucks (powered by Cummins Westport ISL G engines) were recently introduced at the Ports of Los Angles and Long Beach to demonstrate CNG HD drayage trucks abilities to move containers between the San Pedro Bay ports and nearby freight-consolidation yards. CNG trucks would be expected to be commercially available if the technology is successful during the demonstration project.

Figure III-4

Demonstrated CNG-powered Heavy Duty Truck

The CNG HD port drayage truck project proponents ultimately hope to transition the CNG drayage truck technology to a CNG/hydrogen fuel blend technology. Project proponents believe a CNG/hydrogen fuel blend may be able to provide an additional 30 to 50 percent in NOx emissions reductions.

<u>Potential Emission Reductions</u>

In 2005, within the eight intermodal railyards boundaries (with railyard HRAs), heavy-duty (HD) diesel trucks were responsible for an estimated 31 tons per year of diesel PM emissions. The ARB has three statewide diesel truck regulations for new, drayage, and private fleet trucks. However, the ARB drayage truck regulation will have the largest impacts in the near-term at intermodal railyards. ARB staff estimates that the ARB port and intermodal railyard drayage truck regulation will reduce diesel PM emissions by up to 90 percent by 2015, or to about 3.1 tons per year. New CNG heavy duty (HD) trucks could potentially provide earlier and greater emissions reductions beyond the emissions reductions provided by the ARB drayage truck regulation in 2015.

The Ports of Los Angeles and Long Beach have about 16,800 drayage trucks operating at their facilities. On average, the port's drayage trucks are 1995 model year trucks emitting at about 5.0 g/bhp-hr NOx and 0.1 g/bhp-hr PM. However, under the ARB drayage truck regulation, the older diesel trucks will be replaced or required to meet the 2007 new truck PM emissions standard of 0.01 g/bhp-hr (90% reduction) by January 1, 2010, and the 2007 new truck NOx emissions standard of 1.2 g/bhp-hr (75% reduction) by January 1, 2014. See the applicable truck emission standards below in Table III-8.

With an average 90 percent reduction, the eight intermodal railyards diesel drayage truck diesel PM emissions could be reduced from 31 to about 3.1 tons per year by 2020.

As a result, the new 2007 HD diesel trucks or equivalent, required by the ARB drayage truck regulation by 2010 and 2014, provide about the same level of PM emissions reductions as CNG HD trucks. With a reasonable compliance margin below the NOx standard, new 2010 HD diesel trucks may provide about equivalent NOx emissions reductions as current CNG HD trucks. However, staff has assumed that CNG HD trucks will provide a NOx benefit of about 90 percent, as compared to new 2007 HD diesel truck emissions standards, and which is required by the ARB drayage truck regulation by 2015.

Table III - 8
HD Diesel Truck and CNG Truck
NOx and PM Emissions Standards

HD Diesel and LNG Truck Model-Year	NOx (g/bhp-hr)	PM (g/bhp-hr)	NOx Reduced 1995 MY	PM Reduced 1995 MY
1995 Trucks	5.0	0.1	-	-
New 2007 Trucks	1.2	0.01	76%	90%
New 2010 Trucks	0.2 **	0.01	96%	90%
ARB Drayage Truck Regulation (2010 PM/2014 NOx)	**1.2**	**0.01**	**76%**	**90%**
CNG	0.1*	0.01*	98%	90%

* CNG certified emission rates.
** 2010 diesel in-use and actual NOx emissions may be equivalent to CNG.

The Port of Los Angeles (white paper) assumed that the average port drayage truck is a 1995 model year. The ARB Goods Movement Calculation assumes 1995 model year port drayage trucks travel about 40,000 miles per year. A 1995 model year HD diesel truck has NOx and PM grams per mile emissions rates of about 21 and 0.7, respectively, or about 1 ton per year for both NOx and PM.

ARB staff has assumed a new 2007 truck NOx and PM emissions levels (i.e., 5 grams/mile NOx and 0.07 grams/ mile PM) as the baseline for 2014, based on the ARB drayage truck regulation. This would amount to about 446 pounds of NOx (440 lbs) and PM (6 lbs) per year as required for diesel drayage trucks by 2015.

A CNG HD replacement would provide emissions reductions, beyond those required by the ARB drayage truck regulation by 2015, for NOx only at about 90 percent. A 90 percent NOx reduction would provide about 400 pounds per year of NOx emissions reductions beyond the current ARB drayage truck regulation by 2015.

Costs

The cost of a new CNG HD drayage truck is estimated to be about $150,000. A tax credit equivalent to $32,000 would lower the costs to about $120,000. However, the CNG fuel and the CNG fueling infrastructure costs are excluded from this analysis.

Cost-Effectiveness

With capital costs of about $150,000, but allowing for a $32,000 tax credit, capital costs are estimated at about $120,000. Assuming a 15-year useful life, the CNG HD truck replacement cost-effectiveness would be about $20 per pound of NOx reduced. Assuming only the cost difference between a new HD diesel drayage and LNG HD truck of about $10,000 (i.e., $120,000-$110,000), the cost-effectiveness would lower to less than $2 per pound of NOx reduced. Staff assumed no PM emissions reductions, as both CNG and 2007 trucks must meet the same PM emission standard.

5. Analysis of Option 20 - Electric Drayage Trucks Within Intermodal Railyards

Background

Electric drayage trucks use onboard batteries which store and provide electricity to run an electric motor. This technology produces zero emissions from the vehicle, but needs an external charging station to recharge the batteries. This technology has been demonstrated on vehicle platforms ranging from passenger vehicles to trucks.

Technical Feasibility

Electric drayage trucks are currently being evaluated through demonstration programs sponsored by the South Coast Air Quality Management District, U.S. EPA, the Ports of Los Angeles and Long Beach, and others. In 2008, the Port of Los Angeles began demonstration testing of an electric truck for several parameters critical to port applications, including maximum range when full and empty, maximum speed, payload, and charging capabilities.

As a result of the demonstration testing, the Los Angeles Harbor Commission recently approved an order for six electric drayage trucks with Balqon Corporation. Electric drayage trucks should be technical feasible, thoroughly tested, and are commercially available from Balqon Corporation.

Potential Emission Reductions

According to the Port of Los Angeles fact sheet (electric truck demonstration project), an overall calculation of net emissions reductions still needs to be performed in order to take into account the emissions created in the generation of electric power used to charge the truck's batteries. However, for this analysis, staff has assumed there would no direct truck emissions within railyards from electric drayage trucks.

In 2005, within the eight intermodal railyards boundaries (with railyard HRAs), heavy-duty (HD) diesel trucks were responsible for an estimated 31 tons per year of diesel PM emissions. The ARB has three statewide diesel truck regulations for new, drayage, and private fleet trucks. However, the ARB drayage truck regulation will have the largest impacts in the near-term at intermodal railyards. ARB staff estimates that the ARB port and intermodal railyard drayage truck regulation will reduce diesel PM emissions by up to 90 percent by 2015, or to about 3.1 tons per year. New electric HD drayage trucks could potentially provide earlier and greater emissions reductions beyond the emissions reductions provided by the ARB drayage truck regulation.

The Ports or Los Angeles and Long Beach have about 16,800 drayage trucks operating at their facilities. On average, the port's drayage trucks are 1995 model year trucks emitting at about 5.0 g/bhp-hr NOx and 0.1 g/bhp-hr PM. However, under the ARB drayage truck regulation, the older diesel trucks will be replaced or required to meet the 2007 new truck PM emissions standard of 0.01 g/bhp-hr (90% reduction) by January 1, 2010, and the 2007 new truck NOx emissions standard of 1.2 g/bhp-hr (75% reduction) by January 1, 2014. See the applicable truck emission standards below in Table III-9. With an average 90 percent reduction in the eight intermodal railyards, diesel truck intermodal railyard diesel PM emissions could be reduced from 31 to about 3.1 tons per year by 2020.

Table III - 9
HD Diesel Truck and Electric Truck
NOx and PM Emissions Standards

HD Diesel and Electric Truck Model-Year	NOx (g/bhp-hr)	PM (g/bhp-hr)	NOx Reduced 1995 MY	PM Reduced 1995 MY
1995 Trucks	5.0	0.1	-	-
New 2007 Trucks	1.2	0.01	76%	90%
New 2010 Trucks	0.2	0.01	96%	90%
ARB Drayage Truck Regulation (2010 PM/2014 NOx)	**1.2**	**0.01**	**76%**	**90%**
Electric	0	0	100%	100%

The Port of Los Angeles (white paper) assumed that the average port drayage truck is a 1995 model year. The ARB Goods Movement Calculation assumes 1995 model year port drayage trucks travel about 40,000 miles per year. A 1995 model year HD diesel truck has NOx and PM grams per mile emissions rates of about 21 and 0.7, respectively, or about 1 ton per year for both NOx and PM.

ARB staff has assumed a new 2007 truck NOx and PM emissions levels (i.e., 5 grams/mile NOx and 0.07 grams/ mile PM) as the baseline for 2014 based on the ARB drayage truck regulation. This would amount to about 446 pounds of NOx (440 lbs) and PM (6 lbs) per year as required for diesel drayage trucks by 2015.
An electric HD truck replacement would provide emissions reductions beyond those required by the ARB drayage truck regulation by 2015, for both NOx and PM, at about 100 percent. A 100 percent NOx and PM reduction would provide about 440 pounds per year of NOx and PM emissions reductions, beyond the current ARB drayage truck regulation by 2015.

Costs

According to the Port of Los Angeles fact sheet, an electric drayage truck cost is approximately $208,500. The estimated cost of one charging station, which simultaneously charges four trucks, is about $75,000. However, this does not include the cost of construction or additional infrastructure needed to support this technology.

The costs above do not include costs for battery replacement, which based on light duty electric vehicles, is about ten years. An electric drayage capital costs are more than two times higher than a comparable new 2007-2010 HD diesel truck which costs about $110,000.

Cost-Effectiveness

With capital costs of about $210,000 and assuming a 15-year useful life, the electric HD truck replacement cost-effectiveness would be about $31 per pound of NOx and PM reduced. Assuming only the cost difference between a new HD diesel drayage and electric HD truck of about $100,000 (i.e., $210,000-$110,000), the cost-effectiveness would lower to less than $15 per pound of NOx and PM reduced.

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